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Satellite Remote Sensing of Snow/Ice Albedo over the Himalayas

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The Himalayan glaciers and snowpacks play an important role in the hydrological cycle over Asia. The seasonal snow melt from the Himalayan glaciers and snowpacks is one of the key elements to the livelihood of the downstream densely populated regions of South Asia. During the pre-monsoon season (April-May-June), South Asia not only experiences the reversal of the regional meridional tropospheric temperature gradient (i.e., the onset of the summer monsoon), but also is being bombarded by dry westerly airmass that transports mineral dust from various Southwest Asian desert and arid regions into the Indo-Gangetic Plains in northern India. Mixed with heavy anthropogenic pollution, mineral dust constitutes the bulk of regional aerosol loading and forms an extensive and vertically extended brown haze lapping against the southern slopes of the Himalayas.

Episodic dust plumes are advected over the Himalayas, and are discernible in satellite imagery, resulting in dust-capped snow surface. Motivated by the potential implications of accelerated snowmelt, we examine the changes in radiative energetics induced by aerosol transport over the Himalayan snow cover by utilizing space borne observations. Our objective lies in the investigation of potential impacts of aerosol solar absorption on the Top-of-Atmosphere (TOA) spectral reflectivity and the broadband albedo, and hence the accelerated snowmelt, particularly in the western Himalayas. Lambertian Equivalent Reflectivity (LER) in the visible and near-infrared wavelengths, derived from Moderate Resolution Imaging Spectroradiometer radiances, is used to generate statistics for determining perturbation caused due to dust layer over snow surface in over ten years of continuous observations. Case studies indicate significant reduction of LER ranging from 5 to 8% in the 412-860nm spectra. Broadband flux observations, from the Clouds and the Earth's Radiant Energy System, are also used to investigate changes in shortwave TOA flux over dust-laden and dust-free snow covered regions. Additionally, spatio-temporal and intra-seasonal variations of LER, along with snow cover information, are used to characterize the seasonal melt pattern and thus to distinguish the outstanding aerosol-induced snowmelt signal. Results from this observational work are expected to provide better understanding of the radiative impact of aerosols over snow surface, especially its role in the Himalayan hydro-glacialogical variability.